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the relation of animal experimentation to medicine, hygiene and surgery, and the conquest of diseases in the animals themselves. Even though one has followed the principal discoveries in medicine as they have been made from time to time, the results when brought together can hardly fail to surprise one whose attention to such subjects has been only casual.

Some opulent philanthropist who wishes to do a service to the cause of medical science would do well to authorize the publishers to send copies of this little book to every state senator and assemblyman, and every member of the national congress, so that our law-makers may obtain, without more effort than busy men can well afford, a comprehensive idea of methods of research, upon which they are so often importuned to pass restrictive or prohibitory legislation.

Mr. Rockefeller has recently endowed a magnificent institution for medical research. Out of it have already come, by methods which the sentimental zoophilists have so severely condemned, discoveries whose value to the world are many times greater than the cost of the institution. If the well-meaning opponents of animal experimentation had had their way these discoveries would not have been possible. The country would have saved several of its guinea-pigs and homeless dogs, but it would have lost more of its children.

We are never entirely safe from the good intentions of the opponents of vivisection, and it is hoped that Dr. Warbasse's book will be widely circulated and will serve as a corrective of the misinformation which has been so liberally furnished to the public.

S. J. HOLMES

#### SCIENTIFIC JOURNALS AND ARTICLES

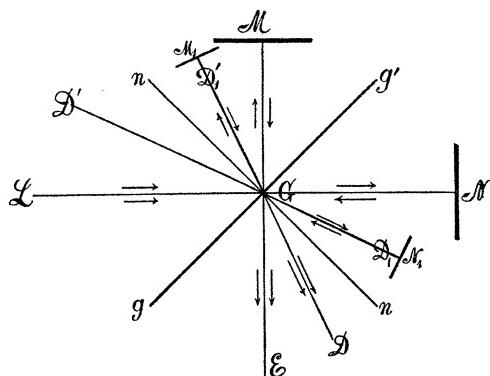
The contents of the current number of the *American Journal of Mathematics* is as follows: "The Osculants of Plane Rational Quartic Curves," by H. I. Thomsen; "On the Primitive Groups of Classes Six and Eight," by W. A. Manning; "Minimalcurven als Orter von Krümmungsmittelpunkten," Von E. Study; "Minimalcurven und Serret'sche Flächen," Von E. Study; "On Steinerians of

Quartic Surfaces," by John N. Van der Vries; "On the Determination of the Ternary Modular Groups," by R. L. Börger; "Groups of Transformations of Sylow Subgroups," by G. A. Miller.

#### SPECIAL ARTICLES

##### ON THE GENERAL USE OF THE GRATING WITH THE INTERFEROMETER

In a recent number of this journal<sup>1</sup> a method was described of bringing reflected-diffracted and diffracted-reflected rays to interference, producing a series of phenomena which in addition to their great beauty promise to be useful. In fact, the interferometer so constructed needs but ordinary plate glass and replica gratings. It gives fringes rigorously straight, and their distance apart and inclination are thus measurable by ocular micrometry. An adjustment may be made whereby ten small fringes occupy the same space in the field as one large fringe, so that sudden expansions within the limits of the large fringe (as in magneto-striction) are determinable. Lengths and small angles are thus subject to micrometric measurement. Finally the interferences are very easily produced and strong with white light, while the spectrum line used may be kept in the field



<sup>1</sup> From a lecture given to the Eastern Association of Physics Teachers, at Brown University, Providence, on May 21, 1910. See also C. and M. Barus, SCIENCE, March 11, 1910, p. 394, and a forthcoming number of the *Philosophical Magazine*.

The same method may be available as an adjunct to either Jamin's or Michelson's interferometers, except that here the transmitted-diffracted and reflected-diffracted rays are brought to interfere. To take the example of the Michelson type stripped of unnecessary details, let  $gGg'$  in the figure, be the grating or ruled surface,  $n$  its normal,  $L$  the source of white light,  $M$  and  $M'$  the mirrors, and  $E$  the eye. In the usual way the rays from  $L$  interfere at  $E$ .

Now replace  $L$  by a slit and collimator,  $E$  by a telescope focussed for parallel rays. The eye at  $E$  now sees a sharp line of light. At  $D$  and  $D'$ , however, there must be two diffraction spectra coinciding in all their parts and hence interfering rhythmically if all adjustments are sufficiently perfected. The other two diffractions within  $MGg'$  and  $EGg$  are often lost at an incidence of  $45^\circ$ .

The attempt to produce these interferences  $D$ ,  $D'$ , with replica gratings is liable to result in failure: for while the transmitted system  $NGD$  shows brilliant spectra, the reflected system  $MGE$  is dull and hazy. Both spectra are clearly in evidence and may be brought to overlap. The film, however, does not reflect in a degree adequate to the transmission. Attempts are in progress to realize the condition of equality with a grating actually ruled on glass or possibly with a modified film.

What is strikingly feasible, however, with ordinary plate glass and a non-silvered grating, is the production of interferences between pairs of diffracted spectra,  $D'_1$  and  $D_1$ , for instance, if returned by equidistant mirrors  $M_1$  and  $N_1$  to a telescope in the line  $D$ . Both of these spectra are very brilliant and not very unequally so, and the coincidence of spectrum lines brings out the phenomenon. This is of the *ring type*, and not of the line type referred to above; but it also occupies the whole field of the spectrum from red to violet. In my first adjustment using sunlight, I obtained splendid large confocal ellipses, with the dark centers in the yellow, the sodium line simultaneously in focus serving as a major axis. It is more usual, however, to obtain oblique lines across the spectrum which are strongest

in certain color fields. In a city laboratory these are perpetually in motion, the rings particularly alternating between dark and bright centers. Naturally a fine slit is of advantage. The theory of these ellipses will be given elsewhere.

CARL BARUS

#### NOTES ON AN EXPERIMENT CONCERNING THE NATURE OF UNIT CHARACTERS

SOME time ago the writer planned<sup>1</sup> a series of experiments designed to throw some light on the nature of unit characters. Only one part, of which the following is a brief extract, has been completed. If an apology is necessary for daring to present negative results, I might say that even if proof of a negative is logically impossible, such evidence does give an idea of the relative frequency of the occurrence of the event in question. It is sometimes forgotten that a small probable error is as desirable in this case as when the results are positive. In addition to this fact, however, it is a pleasure to call attention to a line of experimentation which, though familiar to all biologists, has not had the serious consideration that it deserves. I mean the work of MacDougal in trying to produce mutations or transmissible variations by artificial means. Even if one does not accept as fact that the definite and transmissible changes which have occurred in Dr. MacDougal's injection experiments were caused directly by the introduction of semi-toxic solutions into the mother plant's ovary, he should admit that the method proposed is well worth his earnest attention. It is capable of several modifications and extensions—two of which I shall describe—which if given sufficient trial might yield results with important bearings somewhat apart from the original scope of MacDougal's investigations. Even if many experiments on limited populations should give no positive results, it should be remembered that progressive variation occurs but rarely in nature, possibly but one variant in millions of individuals. One ought

<sup>1</sup> At the Connecticut Agricultural Experiment Station, under the federal appropriation known as the Adams fund.